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Modeling and Analysis of the Brake Disc in Automobiles using ANSYS

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***Abstract**: One of the most important components of modern automobile is brake system and among the components of brake system, brake disc is highly significant. The brake system should be able to decelerate the vehicle any time with full safety and comfort, or stop it, if necessary. The kinetic energy of vehicle is converted into thermal energy due to friction between brake disc and brake pads thereby reducing the speed. In this paper, 3D model of brake disc are built in the software solidwork and exported to finite element of software (ANSYS R16.0). To perform analysis, three materials were selected silicon carbon fiber, white cast iron and HSS M42. A comparative account of equivalent stress, elastic strain and total deformation has been analyzed.*

***Keywords**: Solidswork , Ansys (R16.0), Total Deformation, Disc Brake*

I- INTRODUCTION

Protection and well fare of passenger travelling in car is governed by brake system and plays vital role in control system of modern cars. Brake helps to retard the motion of vehicle and stop in particular distance. The distance from point where brakes are applied to the point where vehicle is stopped is called the stopping distance. Principle of brakes follows conservation of energy. When brakes are applied kinetic energy of vehicle get converted in form of heat energy which is released from brake. Most commonly, frictional brakes are used in present era. Principle of friction brake is to retard the

motion of vehicle with the help of friction force. Friction is developed when the friction pads sticks on the disc from both the direction, which slows down the motion of disc and here with retards the motion of vehicle. This friction raises the temperature of disc and undergoes thermal stress which decrease the efficiency of disc day by day. Therefore, material used for manufacturing the disc is important and proper quality of material that can withstand the frictional force shall be used. For analyzing the properties, we have discussed the analysis of three materials using finite element software ANSYS.

METHDOLOGY

A 3D model of the disc was built in solidworks software as shown in fig 1. The dimensions of the 3D model had disc diameter of the 275 mm, thickness 12.5 mm, inner central diameter 150 mm, extruded length at the center 65 mm, a central hole on the extruded hub of diameter 57.5 mm, and six holes for nut and bolt were made on the extruded part of radius 8 mm. Further saved in step.203 format and was exported to finite element software ANSYS.

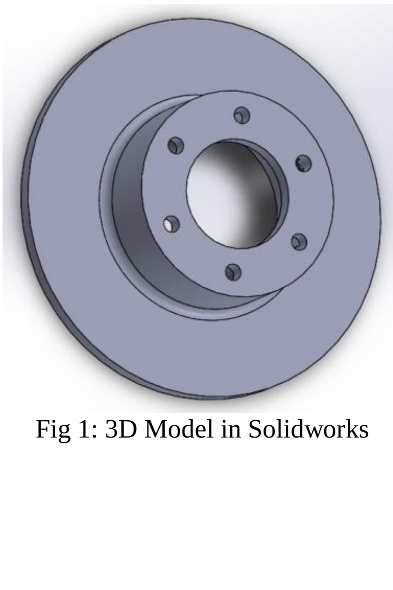

Fig 1: 3D Model in Solidworks

After the geometry optimization, three different materials were assigned to the 3D model in ANSYS. The three materials considered for analysis were Silicon carbon fibre, High Speed Steel M42 and White cast iron. The important properties of these materials are given in table 1.

Table 1: Properties of Material

Properties	Silicon carbon fibre	HSS M42	White cast iron
Density (kg/m3)	4400	7810	7350
Young's modulus	9.2e+10	19.5e+10	17.2e+10
Poison's ratio	.35	0.28	0.26
Tensile strength (MPa)	300	400	586
Thermal expansion (/10^{-6}K)	8.1	11.5	11.9

MESH GENERATION

The main purpose of the finite element analysis is to analyze the 3D model accurately. For the accurate analysis of part it is necessary to convert it into finite elements. The more the element, more is the accuracy. The meshing of part was carried out and number of nodes formed were 9222 as shown in fig 2. There are many shapes of elements, tetrahedral, triangular, hexagonal, etc.

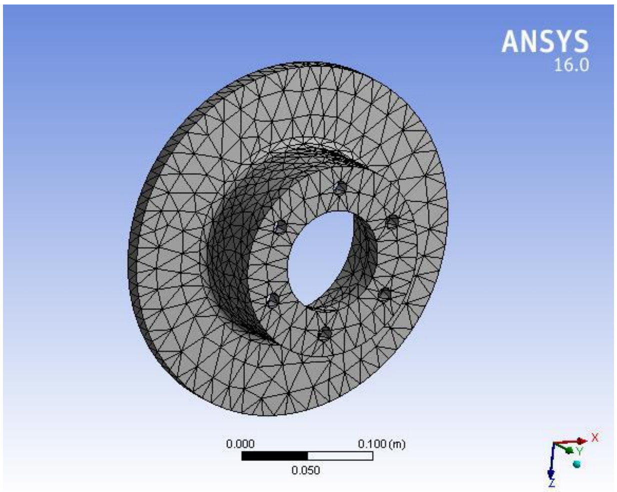

Fig 2: Mesh Generation of Disc with 9222 nodes.

RESULT

On the basis of the analysis and the results, it is observed that the structure made out of three different materials are safe as the total maximum stress is within the ultimate stress limits for the three materials used which is silicon carbon fiber, HSS M42 and white cast iron, as shown in figures, I,II,III (a, b, c) respectively and summarized in table 2

Material: I) Silicon Carbon Fibre

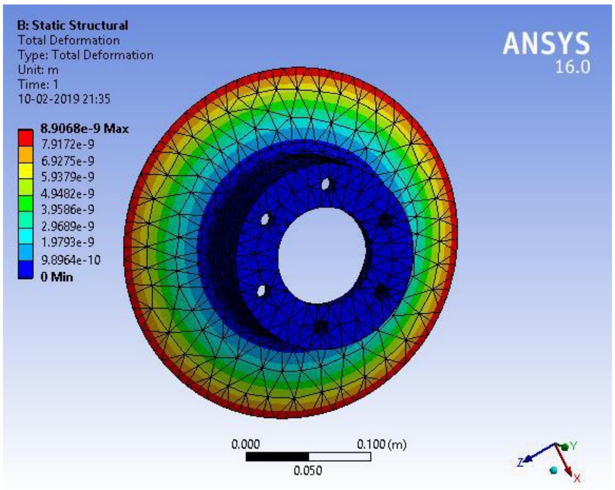

Fig I. a: Total deformation for silicon carbon fibre. The maximum deformation observed is 8.90 x 10-9m.

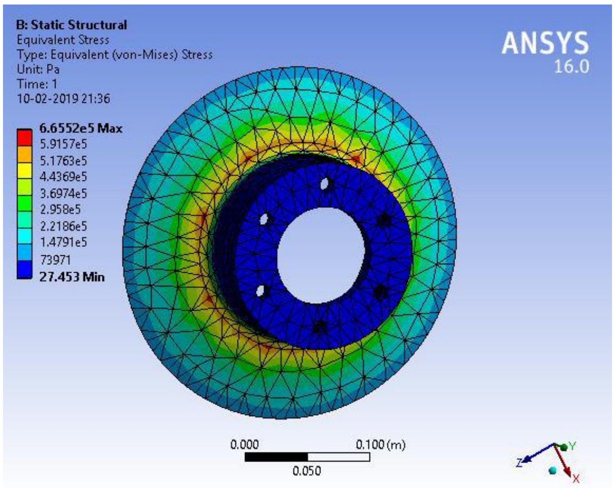

Fig I. b: Equivalent stress for silicon carbon fibre. Maximum value is observed as 6.65 x 105Pa.

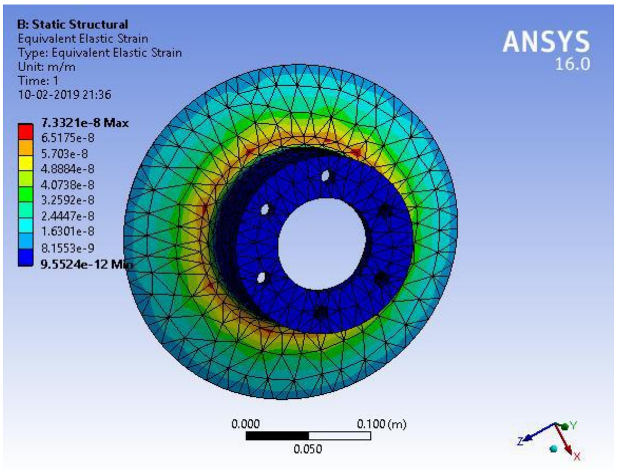

Fig I. c: Elastic strain for silicon carbon fibre. Maximum value is 7.32 x 10^{-8}m/m.

Material: II) High Speed Steel M42

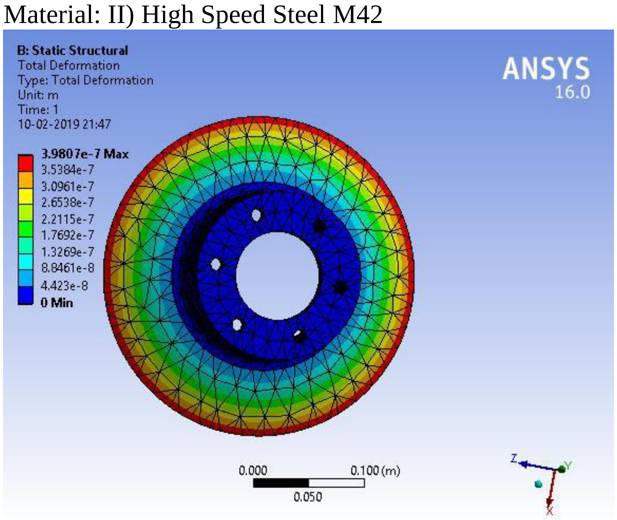

Fig II. a: Total deformation for HSS M42. The maximum deformation observed is 3.98 x10^{-7}m.

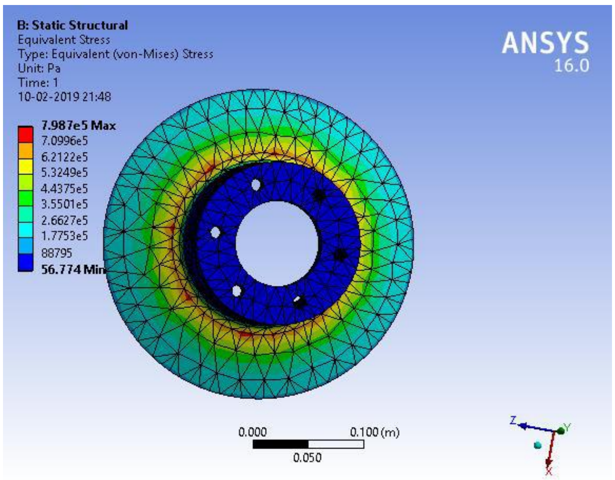

Fig II. b: Equivalent stress for HSS M42. Maximum value found to be 7.98 x10^{5}.

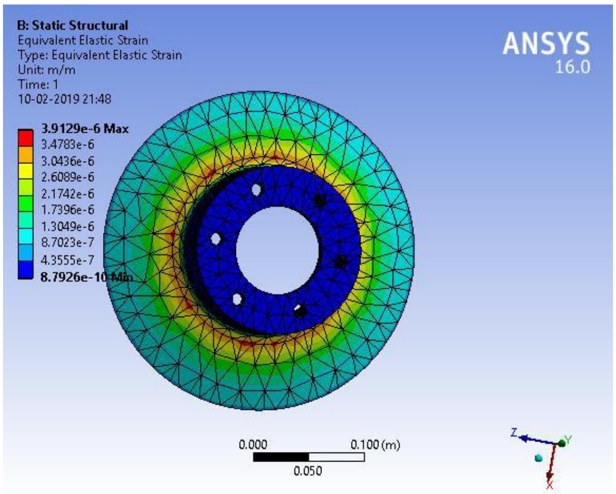

Fig II. c: Elastic strain for HSS M42.

Material: III) White Cast Iron

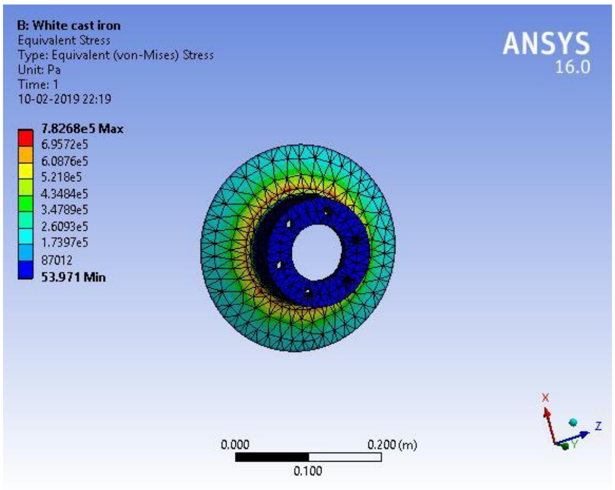

Fig III. a: Equivalent Stress for white cast iron

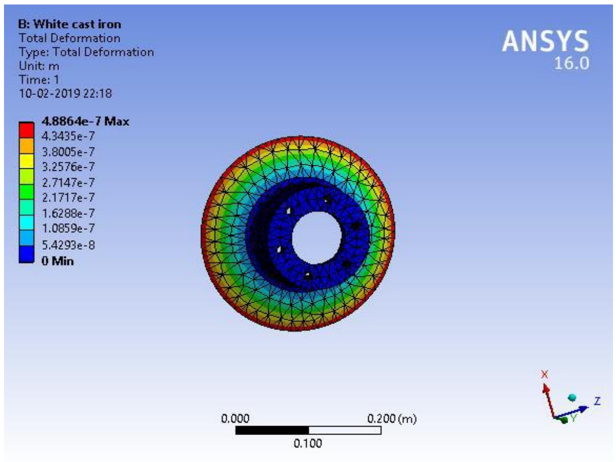

Fig III. b: Total deformation for white cast iron. The maximum deformation observed is 4.88 x10^{-7}m.

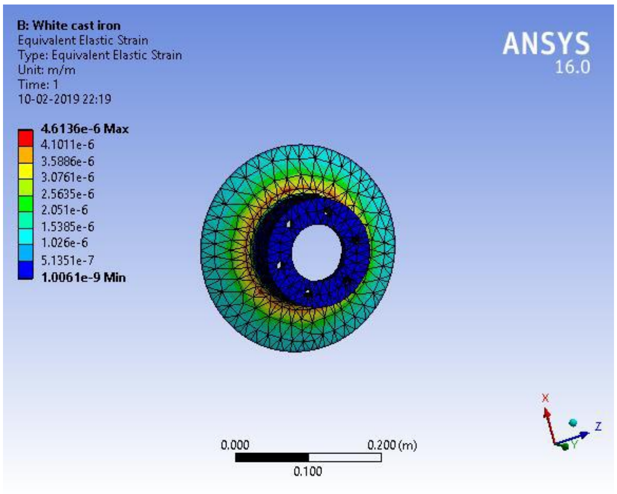

Fig III. c: Elastic strain for white cast iron. Maximum value found to be 4.61x10-6m/m.

CONCLUSION

The disc brake was simulated and analyzed by using finite elements analyzer (ANSYS R16.0). White Cast Iron, Silicon Carbon Fibre and High-speed Steel M42 were selected as materials for disc brake. Total deformation, Equivalent stress and Elastic strain were obtained for all the three materials. It can be observed from the results that the minimum deformation and stress occurred in silicon carbon fibre. And it can well withstand total deformation, equivalent stress and elastic strain, hence it is preferred for manufacturing disc brake to get better performance. For future works, it is recommended to simulate the disc brake with different materials and analyze the performance at various conditions.

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